knowledge that all are workers in the same cause. Men become more vividly conscious that though students of Nature are excluded from the State recognition which is extended to the Church, to medicine, and to the law, they too are members of a great profession. They realize that, though State rewards are given only to those who have applied their knowledge to some directly useful end, in a gathering of the profession of science the true leaders are those who have wrested the deepest secrets from Nature, careless whether they could be turned to gold or no.

A meeting held in great numbers and for a common purpose may have an influence which many an apparently more useful testimonial would lack. Prof. Tyndall has done service in the cause of science which merited the unique compliment he received. He would, we believe, be the first to rejoice if in the future the Tyndall Dinner was remembered not only as a tribute to his own work, but as marking the beginning of a period in which the ranks of science were drawn closer together, and in which the further organization of the investigation of Nature claimed and received the attention which its importance demands.

## *THE GEOLOGY OF ENGLAND AND WALES.*

*The Geology of England and Wales.* With Notes on the Physical Features of the Country. By Horace B. Woodward, F.G.S. Second Edition. (London: Philip and Son, 1887.)

THE student of physical geology has at least two large English text-books, interesting, full, accurate, judicial, and written by masters of the science; but he who would build on this foundation a knowledge of historical and palæontological geology is in a harder case, and finds either a meagre outline containing little but a few meaningless names of formations and fossil lists, or else an ill-digested and formless mass of matter, derived from everywhere, but leading nowhere. Perhaps the time has not yet come when stratigraphy can be treated from the stand-point of inorganic evolution, so that fact may be joined to his fact and an organized whole result.

While, however, we wait for one who shall give us geology in the form of the inorganic and organic evolution of the globe, we must not omit to notice the labour of those whose "work is to record the facts from which the pleasanter deductions may be made." Mr. Woodward has done wisely in republishing by subscription and in an enlarged form his admirable book on the geology of England and Wales—a veritable mine of facts, well indexed and admirably supplied with references for the advanced reader, forming a base-line for further study and research, but complete in itself for the more elementary student and rendered interesting by the author's fresh style, by his capital and apt illustrations, and by his wonderful faculty of seizing upon the individuality of the rock group he is describing and skilfully tracing its variations from place to place. This new edition is improved by a larger and better map, undertaken by Mr. Goodchild, by more free use of sections, illustrations, and fossil lists, and by the employment of local names with tables of correlation.

The author works his way upwards from the lowest rocks, but combines a geographical with a chronological arrangement, and varies his method from system to system in order to adapt it better to the rocks under consideration. Just occasionally one meets with a slip in method, as in the case of the Rhætic rocks, where for no apparent reason he has reversed his usual order and treated the White Lias first. Where the mass of facts is unusually great and somewhat barren of interest, the author has introduced little helps and alleviations for which the student will be truly grateful,—the character of the hero of a system sketched in one graphic touch, the origin of the name of a system or a fossil, or the discussion of the origin of some bed of palæontological or economic value (*vide* pp. 24, 47, 84, 266, 670).

It seems hard to criticise any points of detail in such well-intentioned and well-executed work, but the indication of a few lines for improvement will perhaps show better than anything else how little the author has left for others to suggest. First, with regard to the map. This is clearly engraved, and coloured with light but well-contrasted tints; every name on it suggests some fact interesting from a geologist's point of view, and the effect of the whole is pleasing. There is no special colour for the Permian (not an unmixed advantage), and, oddly enough, the Yorkshire coal-field is left uncoloured; the boundary is engraved, however, and the student can easily fill in the colour for himself. A point has been gained in using a distinctive colour for beds below the Bala, but one lost in not using still another for the lowest Cambrians. The igneous rock colours should have been used less sparingly, and surely the Arenigs and Snowdon deserve a volcanic tint as much as the Borrowdales and the Cheviot rocks. We miss, too, the north of England dikes and the Whinsill.

The book opens with an introduction containing a little history, a little cosmogony, and a few definitions. The latter are hardly needed, and might have made room for the accounts of the geology of different lines of railway, which found a place in the first edition but have been crowded out of this. A few words on the Palæozoic group are followed by an account of the Archæan system, in which too little is said of the new class of work amongst these rocks instituted by Prof. Lapworth, while Prof. Bonney's papers on the Bangor area are almost passed over. The table on page 52 hardly makes it quite clear that the Harlech group of St. David's is divided into the Caerfai and Solva groups, of which the former constitutes the *Annelidian* of Lapworth, and the latter, together with the Menevian beds, the *Paradoxidian*. On page 58 we find the time-worn section across that part of the Longmynd which teaches nothing of the succession of the Longmynd rocks; this and several other sections should have been orientated. On page 60 the Hollybush sandstone is omitted from the table of Shropshire Cambrians, and awkwardly placed on page 65, while the Shineton shales are correlated with the Dolgelly beds and Malvern black shales in the table, though afterwards correctly placed with the Dictyonema shales and Lower Tremadoc. A deceptive appearance of unconformity in sections on page 89 might easily have been removed, even if present in the original woodcut. It is good to see Mr. Lewis's name brought up with

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Murchison's on page 103, in connexion with the Aymestry limestone.

The author mentions, but does not definitely accept, Prof. Hull's correlation of the Devonian rocks. Throughout the work, and particularly in the Carboniferous section, great care has been taken to show and where possible give the origin of the economic value of the rocks. A little more stress should have been laid on the relations of the Coal-measures to the underlying rocks, and one might notice here the absence of the Dudley, Sedgeley, and other inliers from the South Staffordshire coal-field on the map. An important feature consists in the description of Palæozoic rocks from all the deep borings (a list of these forms the first appendix); and a good section to express the present state of knowledge on the deep-seated geology of the London Basin is given on page 202.

The Permian and Lias form a single system, the Poikilitic, which is included in the Mesozoic, the author being guided by the widespread discordance between it and the older rocks. It is not quite easy to understand all the tables (pp. 286, 470), but these only echo the difficulties which exist in the rocks themselves. It would have been as well if the Yorkshire Cornbrash had found a place after the Upper Estuarine on page 321. A good opportunity was missed of discussing the anomalous beds of Faringdon and Blackdown, particularly in relation to Mr. Starkie Gardner's recent papers on kindred questions; and we should have liked to see the grit phases in the Jurassic clays of the eastern counties more accurately defined. A section might have been introduced to show the thinning of the Gault and growth of the Cambridge nodule beds; and Mr. Sollas's work on flints ought not to have been omitted.

The Upper Eocene beds are classed as Oligocene, but the Brockenhurst bed is put in its true place in the Headon.

There are some very suggestive remarks on the connexion between health and geology, between villages and springs and consequently the outcrop of porous rocks, and on the effects of percolation of spring and sea water through rocks. The section on igneous rocks is of necessity somewhat vague and unsystematic from its brevity, but room has been found to treat the volcanic rocks historically; the Nuneaton diorites are intrusive in pre-Carboniferous rocks only. There are concluding chapters on metalliferous deposits, and on scenery and geology, the latter containing a useful list of hills, valleys, plains, and forests.

A little more space might with advantage have been spent in indicating with greater fulness what is known of the physical geography of the different periods, and epochs of earth movements, their dates, directions, and effects should have been more fully dealt with in the last chapter. A capital synopsis of the animal kingdom is furnished in an appendix by Mr. Edwin T. Newton; and a grand index, occupying 45 pages of three columns each, and giving the dates of the birth and death of authors referred to, closes the volume, which is an excellent summary of the present state of our knowledge of British geology. The author has worked conscientiously and well, and that we have been able to suggest so few additions clearly shows that his labour has not been in vain.

W. W. W.

## A TREATISE ON GEOMETRICAL OPTICS.

*A Treatise on Geometrical Optics.* By R. S. Heath, M.A., D.Sc., Fellow of Trinity College, Cambridge, Professor of Mathematics in the Mason College, Birmingham. Demy 8vo, pp. xvii. 356. (Cambridge: University Press, 1887.)

THIS treatise is based on the conception of a beam of light as consisting of a system of rays, which obey the laws of reflexion and refraction. The transformations of such a system and the construction and properties of optical instruments are deduced, so far as the latter are capable of explanation from this point of view.

In confining himself to geometrical optics in this sense, the author follows the mode of division of the science which has been usually adopted in text-books in this country, through the succession of Cambridge treatises by Coddington, Griffin, and Parkinson, and Lloyd's "Treatise on Light and Vision." The subject then splits up naturally into the theory of reflexion and refraction of systems of rays, which is in fact a department of geometry; and the more special discussion of the nature of optical instruments and the forms and positions to be given to their refracting surfaces to diminish spherical and chromatic aberration, which allies itself with the technical science of optical construction.

The book begins with a short chapter on the nature and properties of light, in which the theory of illumination is worked out as a consequence of the experimental fact that self-luminous surfaces appear equally bright in all directions and at all distances. The second and third chapters contain the statement, in geometrical and analytical form, of the laws of reflexion and refraction, and the investigation of conjugate foci for direct pencils.

In Chapter IV. the subject of refraction through lenses and systems of lenses is treated, use being made of the symmetrical analysis, by means of the convergents of continued fractions, to determine the principal points of a system whose refracting surfaces are specified. Free use is also made of the cardinal points of the system in the semi-geometrical manner introduced by Möbius. The following chapter is devoted to an account of the general analytical investigation by means of which Gauss placed the whole theory on an independent basis. The notion of the equivalent lens is here introduced to some practical purpose, for the investigations of this and the preceding chapter enable the author to specify the exact character of the equivalence that can be secured by a single lens or a single refracting surface: viz. that if the lens or surface occupied the position of one of the principal planes of the system, it would refract any beam incident along its axis into the same configuration as it actually possesses when it emerges through the other principal plane of the instrument; so that, neglecting aberrations, the equivalence holds in every sense except as regards the displacement along the axis, and is therefore complete for most practical purposes.

The theory of caustics is treated, chiefly by analytical methods; and the existence of wave-surfaces, which cut the system of rays at right angles in an isotropic medium, is established geometrically.

Chapter VII. is devoted to the discussion of the spherical aberration of direct pencils, which is perhaps

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